Development of a Direct-Injected Natural Gas Engine System for Heavy-Duty Vehicles

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2/96–2/97

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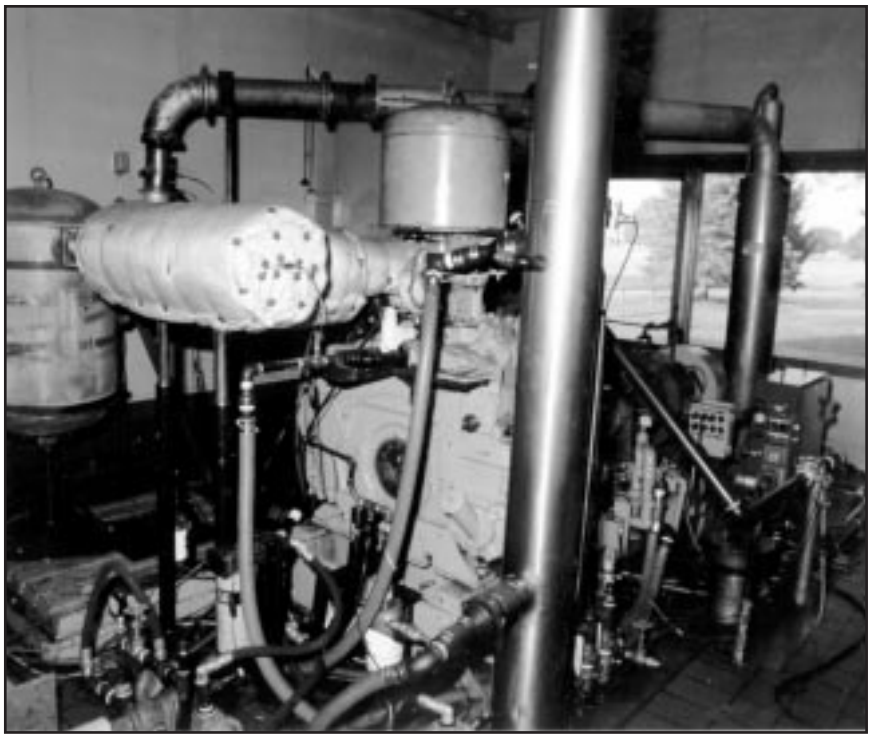
Objective

Develop a commercially viable direct injection (DI) natural gas engine system on a four-stroke diesel cycle. The goal is for the engine to match the power, thermal efficiency, heat rejection, and durability of its diesel counterpart. The initial engine-out emissions goals are NO_x <2.5 g/hp-h and particulate matter <0.05 g/hp-h.

Approach

In this phase of the program, Caterpillar will use a 3516 multi-cylinder engine (4.3 liters/cylinder, 16 cylinders) to perform durability testing, and a 3501 single-cylinder engine to perform emission reduction testing. After a brief durability test, the 3516 engine will be disassembled and inspected to identify areas of needed improvement. Based on the results of the initial durability testing, design modifications shall be made and incorporated into the engine. The 3501 single-cylinder engine shall be modified to meet an initial goal of 2.5 g/hp-h NO_x emission level. Engine testing must show that the engine will meet this goal over an applicable heavy-duty vehicle engine cycle. Caterpillar will investigate the current level of 3000 psi fuel delivery technology both for CNG and LNG, focusing on vehicle applications and economics. This study shall identify components that require further development for the fuel handling system to be commercially viable.



Caterpillar 3501 (single-cylinder engine)

Accomplishments

The 3516 engine has accumulated a total of 225 hours and has been to 1500 rpm and 1475 kW, which is 95% of rated diesel power. Based on results to date, the key area of needed improvements will be in sealing the high-pressure natural gas inside the gas injector, and the glow plug system. The 3501 single-cylinder engine is opera-

tional and baseline emissions data are being taken. Hardware to reduce emissions has been procured and will be tested following the baseline testing.

Future Direction

Tests will continue on both engines. Following durability testing, the 3516 engine will be inspected and modifications for improvement will be identified. Techniques for achieving NO_x <2.5 g/hp-h will be identified on the 3501. In future program phases, Caterpillar will demonstrate the durability of the 3516 engine under simulated field test site conditions, determine the feasibility of <1.0 g/hp-h NO_x emissions using the 3501 engine, and demonstrate a durable 3000-psi fuel handling system.

Publications

None to date.

Caterpillar 3516 (16-cylinder engine)